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ON THE NOTION OF ORDER IN THE UNIVERSE.

MEN have always been struck by the fact of the regularity of astronomic occurrences, and also, though in less degree, by the alternation of the seasons on the earth, which depends upon these celestial movements, by the reproduction of living creatures, whether vegetable or animal, in conformity to their specific type, and, finally, by the repetition of a thousand common phenomena of heat, light, electricity, or affinity under similar or analogous circumstances.

Through the observation of these phenomena there is introduced to our minds the idea of order, and at first this idea signifies periodicity, constant recurrence, because of the aspect of phenomena which impress their first or most obvious mark upon it. But analysis soon shows that this is only a crude and superficial mark; an appearance of stability hides from our short sight the incessant changes of the universe.

Even in the movements of the heavens we discover inequalities and perturbations. The solar system, to which we belong, is but a dab of matter wandering among millions of systems which people space. Imperceptible internal modifications in the course of time alter the relations of velocity and mass within it so as to disturb the economy of the whole; nothing recurs constantly in the same number and form, and we are forced to recognise that the periodicity of these astronomic movements, regular as they seem to our brief observation, is only relative and depends probably on wider systems of periodicity whose rhythms and times we know not,

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*Translated from the original manuscript by W. H. Carruth, University of Kansas.

In physical and chemical phenomena,—and in the end everything is reduced to the relations comprised under these two names, that is, to the laws of the constitution of matter,—things present themselves to us under this same double aspect; on the one hand, the constancy of the qualities of matter and the permanence of its laws; on the other hand, the diversity of circumstances, the accidental conjunction of the conditions which cause this quality to manifest itself or that combination to result; here the most rigorous determination, by which every fact is what it is; there the contingent element, that is to say, the seemingly fortuitous concourse of series of events which might not have come about in this particular point of space and at this particular moment of time.

The notion of order would be reduced, then, to this: that the same causes always produce the same results. It would mean the necessity of the consequences under equality of conditions. But it would not do to understand this in the narrow sense of periodicity, as implying the inevitable recurrence of the same conditions, the recommencement of the same phenomena without assignable or possible limit.

As far as we can comprehend it, the world seems to us to be organised for the sake, in a word, of variety, rather than for repetition. The very constancy of the laws permits all the possibilities. When we consider that every substance has its particular properties of density, expansibility, radiation, conductivity, etc., and its fixed equivalent of combination; that for every gas, for instance, there is a critical temperature, below which this gas resists all pressure, and then, that at this temperature pressure on the contrary turns it into a liquid; if we reflect upon the interdependence of all facts, so that the very least action is re-echoed throughout the universe, then we shall comprehend without difficulty that the possibility of new arrangements in it is indefinite and so enormous as to transcend all efforts of the imagination.

And yet, science succeeds none the less in its generalisations. The three domains of light, electricity, and magnetism, which formerly were separated, are to-day united. Thermodynamics, limited at first to the study of the expansion of bodies and to their changes of condition, now comprises the theory of thermo-electrical phenomena. Immutability, which was formerly regarded as a mark of the class of chemical facts, is doubtless so only in appearance, and the difficulty of finding a mechanical explanation for these facts is due solely to the extreme complexity of the elements under consideration. Moreover, the essential point for the success of our theory is that the relations established among objects supposed to be simple remain the same when their complexity is recognised.[1]

Thus the great variety of possibilities is not a lack of order, since human intelligence manages to find its way among them, being guided by the permanence of elementary qualities and by certain simple principles, such as that of the conservation of energy and that of least action. It is not a lack of order, since the success of our hypothesis depends on their very simplicity. The scientist, after the manner of the poet, imagines analogies, and only those are fruitful which enable him to figure out a connection between series of facts which had appeared to be disconnected.

II.

The living world presents the same contrast. A miracle, which is repeated every day, strikes our attention here at once: I refer to the constant reproduction of beings by generation. In spite of accidents, this is accomplished with regularity for each species. From every fertilised egg there comes forth a new animal of complex organism whose acts are spontaneously co-ordinated with reference to its purpose, which is to live. And the typical form of each creature is so indelibly fixed in the egg or in the seed, faintly differentiated as their germs are to our eyes, that it always develops as the same in its essential characteristics as soon as the favorable conditions of æration and temperature coincide.

As a consequence of these very facts, when we consider the variety of structures of the vast number of creatures and their succession in time, in which is revealed in the whole the growing complexity of their mechanisms, the hypothesis is forced upon us that the successive,—if not progressive,—variations of these mechanisms could not fail to correspond to mutations in the conditions of existence. Definite variations, although of limited scope, are produced under our very eyes; the probable causes of them are known to us,—modifications of the environment, the struggle of the organism to adjust itself to new conditions, selection, the inheritance of acquired characteristics. It is even possible for us to add to the work of nature, by making these means serve us in our own experiences.

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[1] Poincaré.

Over against a relative constancy, here also appears the accidental, the casual. Whether it be transformation or creation, the spectacle is the same in both cases. But the intervention of the casual, that is to say, of the new, of realised possibilities, is subject here in the living world to the law of constant development comprised within the limits of a definite periodicity, which is the life of the planet itself, whatever be the actions which have supervened in the course of this development.

Low temperatures, as has become known lately, diminish the resistance of metals to the transmission of electricity in such proportion that an extremely strong current has been successfully made to pass over a conductor of the smallest diameter, after it had been cooled by plunging it into liquid air. This fact helps us to comprehend how, in an egg, a little vesicle of only a few hundredths of a millimeter in diameter nevertheless contains all the properties necessary to the development of a living being, and at the same time holds in concentrated form all the states of being of previous generations. Furthermore, since such an extremely small quantity of matter suffices for the development of vital energy, it enables us to realise what varied aspects life in other planets may present, what superiority of organism other humanities peopling other worlds might possess.[2]

Moreover, is it not a sufficient explanation of such a variety, that the life of higher organisms results from the harmonious activity of hundreds of thousands of living elements, while these elements are in their turn the result of reactions of hundreds of thousands of atoms?

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[2] D'Arsonval.

Thus in their realm the domain of the possible is equally unlimited. At the same time that she is repeating herself, Nature does not weary of producing anew. A like law of simplicity is found, as one may well believe, in this diversity. Science succeeds here also, in guiding herself by a principle which is analogous to the principles of the least action and the conservation of energy, that of finality or teleology.

The more one studies at close range the physiological machinery, the more one is struck by the adaptation which exists between the various organs and their function. From vegetables to animals, from the humblest creatures to the highest, there are revealed delicate adjustments and proportions which one might consider intentional. Teleology, one may say, is a hypothesis inseparable from the investigation of life; it is a monster which we exorcise but do not kill. Science cannot dispense with it, even when she rejects it under this name; if she is ignorant of the use of a piece of organism, she applies herself to discover it; and these precise determinations of vital adaptation constitute physiology itself.

It is doubtless possible to reverse the proposition and say that the eye was not made to enable the animal to see, but that the animal sees because eyes came to it. At bottom this is only a childish equivocation, for the miracle then consists in attributing to the predestined or fortuitous play of physical and chemical laws the formation of an apparatus so complicated as that of vision, with its parts so specialised and so precisely adjusted: the transparent and lenticular media, the retina, the motor muscles, the specialised nerve, the rods and cones, the sclerotic and choroid membranes. And this miracle is renewed in constant variety for each of our senses, for our apparatus of locomotion, for our viscera, up to the ultimate marvel of the brain, in which is produced the consciousness of self.

No less striking is the picture of the adjustments of life if we consider the ways of animals, the curious habits of bees, for example. They all adapt themselves to one end, which is the success of the hive and the preservation of the species. They do not repeat themselves in an automatic way; they vary according to circumstances, and their keepers know how to arouse, or to utilise to their own profit, these intelligent variations of instinct.

It is true that we are dealing here with machines already perfected. The aspect of the matter is different if we consider the phenomena of elementary life. Teleology in cells or plastids seems reduced to simple reactions. But the sequence of these reactions in the course of development is none the less worthy of remark. It will be useless for us to trace back the intelligent act to the instinctive, instinct to the simple reflex, the reflex to the chemical reaction, and to imagine the successive stages of this astonishing evolution; we shall not have eliminated for all that the essential problem of the co-ordination of the reflexes with reference to an end which is the same in every instance, and whose interpretative value is never zero or negligeable for the scientist.

In sum, and without wishing to draw any premature inferences from this principle, it remains true that the biologist in his turn, in beginning the study of life by studying its elements, takes for granted the unity of the living world, as does the physicist the unity of the physical world. Between these two worlds there exists without doubt a hiatus; the gulf appears impassable when we consider only the phenomena of the life of higher organisms. It is less profound when we descend to origins; science does not despair of connecting the facts of elementary life with the general properties of matter, and the success of such an attempt will be the clearest testimony that can be furnished of order in nature. For we can suppose and affirm it to exist there definitely only in proportion as it exists for our minds and is formulated in our knowledge.

III.

The reactions which constitute the life of a plant, even if they can be reduced to laws of physics and chemistry, are none the less a unique phenomenon compared with the simple reactions of inorganic matter. Still more delicate are the reactions of animate beings, in proportion as they depart more and more from the type of vegetative life: sensibility, consciousness, volition, increase with complexity of organism and abundance of forms, and here we have an ultimate transmutation of energy whose scope is assuredly considerable in the economy of the universe.

The results of co-operation, so remarkable even in the communal life of the lower animals, take on their true importance in communities of human beings. Here we see individuals springing from one another yet retaining more or less resemblance, in the same manner as plants and animals. Something, however, changes in them, their morals or their mentality, and these inward changes are expressed outwardly by entirely new relations which are made effective in some other way. The same aim which governs the animal world has impelled man to his social arrangements, and this aim is living, the satisfaction of all demands of life. But we also see how in society he becomes more the master of the conditions of his existence.

Something of initiative seems, then, to be thereby introduced into the necessary train of events; a great complexity of facts is met by an increasing contingency whose maximum is found in the thought of man; necessity, if I may say so, is transformed to a free and reflex action in passing through our consciousness.

One of our most learned philosophers[3] recently opposed to the theory of evolution that of dissolution. He very ingeniously showed, supporting his argument frequently with strong proofs, that all things in the psychological and social order as well as in the mechanical tend toward assimilation, not to differentiation. The actual course of events in the world would nevertheless be such that we should still be permitted to predicate an opposite course. Dissolution and evolution doubtless represent only phases of a universal rythm whose ultimate reason we do not know, and it remains admissible to postulate periodicities of immense duration, into which would fit our phenomenal world, perpetual new beginnings offering constantly new combinations regulated by the same general laws, the same determinism which perpetually governs other contingencies.

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[3] M. André Lalade.

To resume, the constitution of the world appears to us to be such that the domain of the possible has no limits there. The variety of phenomena is so bewildering even to the human mind, that the success of science in this field has been doubted. It is undermined on one side even while it is being built up on the other.

In truth, science would be impossible if there were not, in spite of all, stable relations in nature. It would be impossible, furthermore, if there did not exist a general system, a direction of evolution, reaching even to communities of human beings, and it is upon the hypothesis of such an order spontaneously sprung from common observation, that the knowledge of psychological and social facts is founded.

IV.

Death is necessary to life. We see creatures, from the least to the greatest, struggling among themselves for the means of existence, devouring one another for food, or destroying one another for the sake of gaining more room. The economy of our world is as hard to comprehend without this law as it would be without the equilibrium of seasons, winds, and waters. But our sensibilities revolt at that which our reason explains: and this disagreement enters into our judgments. Justice, goodness,—whence do we derive these ideas which rise above the mere resistance to pain? How does it happen that we are constituted so that we oppose our ideals to the fatality of things and labor to subdue the forces that govern us? In whatever way this attempt is interpreted, it remains true that man is also a part of nature and that his reason, weak as it is, can and must have its place therein. The laws of our sentiments and of our understanding are not our work; they constitute a part of the great whole. Our inner logic must conform to the logic of this universe in order that it should be depicted thus in our brains. The consciousness of self cannot be pure accident, the individual a nullity, the intelligence which reflects the world a fleeting gleam; and hence our attention is fixed upon the vast extent of an horizon which one cannot narrow down without lessening his own function as a thinking man.

In the class of physical and chemical phenomena we have seen only constant and necessary relations: no system seemed invariable except alternating and compensating destruction and recomposition.

In the phenomena of life we have perceived a law of adaptation: a development, or progressive course, across specific or individual cycles; the action of an internal finality which groups and directs for a time the uncertainties of general conditions. But the purpose is perceived only from without, interpreted with reference to the needs of the mind which conceives it; and the purely psychological problem of teleology remains to ascertain whether consciousness precedes adaptation, or whether it follows and accompanies it.

In the class of social phenomena there appears, over and above an end perceived and desired and a perceptible order, the consciousness of a plan, the idea of a higher control exceeding the limitations of simply biological beings. But the conception of such a plan is founded only upon an analogy between our thoughts and a thought in the world; nevertheless it is permissible, since it is innate, since it is realised in part by our own efforts, and since we ourselves are comprised in this universe. It is the definition of the plan, of the desired order, which remains impossible and chimerical, apart from what we conjecture and imagine concerning our own destiny.

Constant relations, an order, a plan, such, then, would be the stages of the philosophical hypothesis. We follow them up to the last, in spite of our reservations, when once we have reached this critical point where our inductions exceed our data, and the mind with difficulty resigns itself to not crossing this indeterminate frontier which separates verifiable conjecture from that which cannot be verified.

LUCIEN ARRÉAT.

PARIS, FRANCE, 1904.